Efficient and Accurate Computational Framework for Injector Design and Analysis, Phase I

Completed Technology Project (2006 - 2006)

Project Introduction

CFD codes used to simulate upper stage expander cycle engines are not adequately mature to support design efforts. Rapid and accurate simulations require more versatile grid frameworks to handle complex geometries of multi-element injector configurations. Turbulence models require upgrades to better predict fuel/air mixing with swirl and to predict heat flux. The innovation proposed initiates work towards developing a mature, high-fidelity simulation tool. Geometry complexity and numerical accuracy problems are addressed via a multi-element UNS grid adaptation strategy that builds upon techniques developed for valving problems and scramjet injectors. Turbulent mixing and heat transfer are upgraded by including PDE's that solve for temperature and species variance (yielding local values of Prandtl and Schmidt number), as well as swirl corrections. Finally generalized preconditioning that accounts for stiffness resulting from a large range of Mach numbers, and generalized thermodynamic formulations for real fluids will be matured to yield robust numerics with improved solution convergence. The tools and technology to be developed here would directly impact design efforts for future long duration lunar and Mars missions that require more durable long-life, light weight system components, and address methodology to operate with novel hydrocarbon fuels that may be harvested in-situ.

Primary U.S. Work Locations and Key Partners
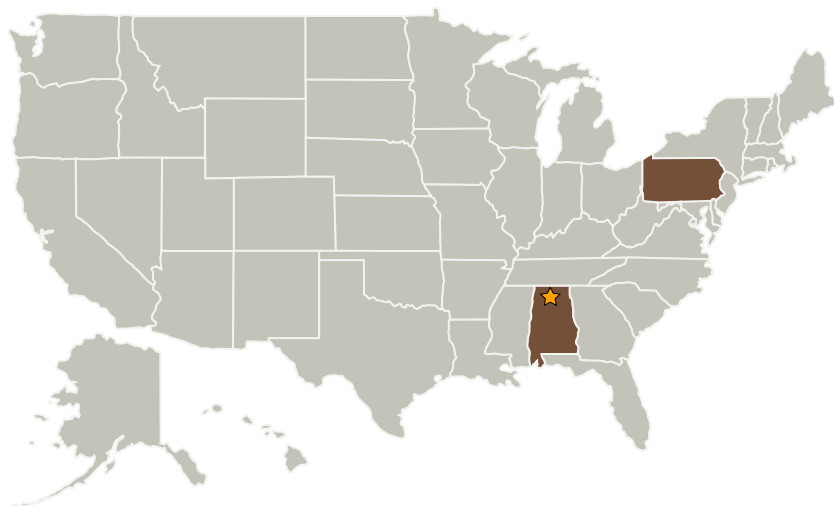
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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Marshall Space Flight Center (MSFC)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Organizations Performing Work	Role	Type	Location
⭐Marshall Space Flight Center(MSFC)	Lead Organization	NASA Center	Huntsville, Alabama
CRAFT Tech - Combustion Research and Flow Technology	Supporting Organization	Industry	Pipersville, Pennsylvania

Primary U.S. Work Locations	
Alabama	Pennsylvania

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Technology Areas

Primary:

- TX09 Entry, Descent, and Landing
  └ TX09.4 Vehicle Systems
    └ TX09.4.5 Modeling and Simulation for EDL